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Trephine arthrodesis of subtalar joints: operative technique and clinical effect

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Objective: To review the operative technique of trephine arthrodesis of subtalar joints and evaluate its clinical effect.

Methods: From June 1998 to October 2006, we performed subtalar arthrodesis on 38 feet of 34 patients for a variety of painful disorders of hindfoot with trephine technique. Clinical and radiologic follow-up evaluations were performed for 45 months on average (range, 21 to 110 months) after arthrodesis.

Results: No severe complications were found in this study except one patient with dropfoot and two with skin necrosis. The average ankle-hindfoot scores of the American Orthopaedic Foot and Ankle Society (AOFAS) was improved from 48.3 preoperatively to 79.2 postoperatively (P<0.05). The pain scores of visual analogue scales (VAS) decreased from 7.2 (range, 3 to 10) preoperatively to 2.6 (range,1 to 6) postoperatively (P<0.05). Subjectively, the patients experienced improvements in pain, function, cosmesis, and shoewearing. Overall, 30 patients were satisfied and all patients would have this procedure again under similar circumstances. Postoperative radiology showed that complete union was found in 35 feet 6 months after operation, with the successful union rate of 92.1%. There was an increase in arthritic scores for 5 ankles, 4 talonavicular joints, 4 calcaneocuboid joints, and 4 midfoot joints. Nonunion occurred in 3 subtalar joints with anterolateral approach, which required revision arthrodesis.

Conclusion: Isolated subtalar arthrodesis with trephine method is an effective procedure for painful malalignment of hindfoot.

Key words: ***Arthrodesis; Subtalar joint; Radiology***

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Although triple arthrodesis is an effective procedure and a good choice for painful and deformed hindfoot for a long time, there has been a trend in recent years to perform limited hindfoot arthrodeses.[1,2] Subtalar arthrodesis can fuse the talocalcaneal joints. Isolated subtalar arthrodesis is an effective treatment for rearfoot with pain and deformity.[3] The traditional methods of subtalar arthrodesis include extra and intra articular techniques, using structural or cancellous bone grafts and a variety of fixation methods. However, those methods have disadvantages of big trauma and damnify in the talocalcaneonavicular joints, so affecting the long curative effects and sparking the interests of surgeons in exploring new procedures to fuse subtalar joints. We designed a new method of using trephine to fuze subtalar joints and aquired satisfactory clinical effects. The purpose of this study was to review the surgical procedure and its fusion results to determine whether similar or improved function as a normal joint could be achieved with this procedure.

METHODS

From June 1998 to October 2006, 38 feet of 34 consecutive patients (21 males and 13 females, aged 36-68 years, mean=43 years) received fusion of the talocalcaneal joints with trephine in our hospital. Preoperative diagnoses included posttraumatic arthritis in 18 feet, primary osteoarthrosis in 9, rheumatoid arthritis in 6 and severe tarsi sinusitis in 5. The main clinical manifestations were severe pain in the talocalcaneal joints and slight deformities in some patients. The main surgical indication was arthrosis unresponsive to a minimum of 6 months of conservative treatment, including nonsteroidal anti-inflammatory medication, custom orthoses, and physical therapy. The width and length

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of talocalcaneal articulation and the talocalcaneal angle were measured according to preoperative radiographs to select appropriate trephines. All the patients were available for review at a mean follow-up of 45 months (range, 21 to 110 months). Clinical evaluation was based on the ankle-hindfoot score of the American Orthopaedic Foot and Ankle Society (AOFAS) [4] and the pain grades of visual analogue scales (VAS), in addition to subjective assessments of pain, function, shoewearing, cosmesis, and overall satisfactory rate. Radiological evaluation included radiographs and computed tomography (CT) scans. All fused joints were assessed for union with radiological evidences. Nonunion was defined as incomplete healing 6 months postoperatively. Progression evaluation of adjacent joint arthritis was quantified based on a four-point scoring system used by Graves et al[5].

The ankle-hindfoot score of AOFAS was based on a 100-point rating scale, which was used to quantify the clinical outcome.[4] The maximal attainable score for our patients postoperatively was 94 because the six points awarded for subtalar motion were lost with successful arthrodesis of the joints. A subjective questionnaire was used to compare the preoperative and postoperative subjective parameters. Function assessment was based on the number of blocks that the patient was able to walk comfortably. The appearance of the foot was graded as better, worse, or unchanged. The patients were also asked to grade their ability to wear different types of shoes and their dependence on orthoses. Satisfaction was graded as very satisfied, satisfied with minor reservations, satisfied with major reservations, and dissatisfied. Finally, all patients were asked whether or not they would have the procedure again if faced with similar circumstances.

Statistical analysis was performed with matched-pairs *t* test to compare the preoperative and postoperative AOFAS scores and pain scales. Statistical significance was defined as a *P* value<0.05.

Surgical procedures

The surgical procedures involved two operative approaches according to the lesion position: posterolateral approach and anterolateral approach.

In this study, 27 feet adopted posterolateral approach. In details, the patient was placed horizontally on an operating table with a sandbag under the ipsilateral leg and a pneumatic thigh tourniquet was used. A 5-cm incision was made from the lateral side of the Achilles tendon to the lateral malleolus (Fig.1A). Skin and subcutaneous tissues were excided and bilateral skin flaps were dissociated. Care was taken to avoid injuring small saphenous veins, the sural or superficial peroneal nerve. The retinaculum musculorum peroneorum was excided, then the musculus peroneus brevis and longus tendons were pulled aside anterolaterally to expose the subtalar joints. A guidewire was placed in the middle of the posterior articular surface from the cranial lateral side to the caudal medial side using an X-ray projection. The articular surface was then destroyed and parts of the astragalus and the calcaneus were exscinded by using an appropriate trephine along the direction of the guidewire (Fig.1B). The trephine was pulled out and the exscinded cylinder bone bolt was taken out (Fig.1C). The bone bolt was rotated for 90° for orthotopic transplantation (Fig.1D). Finally, the incision was interruptedly sutured and the ankle was immobilized with plaster bandages on the functional position for 12-16 weeks.

A total of 11 feet adopted anterolateral approach. Incision was situated in the anterolateral ankle and the tarsi sinus position (Fig.1B). Care was taken to identify and protect the skin branch of the superficial peroneal nerve when superior and inferior extensor tenaculums were unfolded. The long extensor muscle digits were pulled aside and the soft tissues in the tarsi sinus were cleared to expose the anterior subtalar joints. Part of the articular surface, astragalus and calcaneus were then denuded along the axile direction of the anterior and medial talocalcaneal articulation surfaces with an appropriate trephine.The exscinded bone bolt was also rotated for 90° for orthotopic transplantation. If fewer substances of the bone were exscinded and parenchyma was included, iliac crest bone graft was necessary. Postoperative disposal was the same as the posterolateral approach.

The talocalcaneal joints were generally called the subtalar joints. According to different locations of the articular surface, subtalar joints included anterior, medial and posterior articular surfaces.[6] According to Gray's anatomy, posterior articulation was the real subtalar joint, and the anterior parts of the talocalcaneal joints were defined as the talocalcaneonavicular joints. The

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posterior articular surface had an average area of 677.3 mm^2 (range, 600.5 to 754.1 mm^2). With the formula S=1/2 π Dh ("D" representing the trephine diameter and "h" representing the cylinder bone sagittal length), the surface area of the half exscinded bone bolt was about 426 mm^2 using a 12-mm-diameter trephine, which was about 62.9% of the posterior articular surface area. When using a 13-mm-diameter trephine, the exscinded area was about 66.3% of the posterior articular surface area. Therefore, using an appropriate trephine (D=12 mm or 13 mm), we could destroy an average of 65% of the articular surface and would fulfil the requirement of fusion.

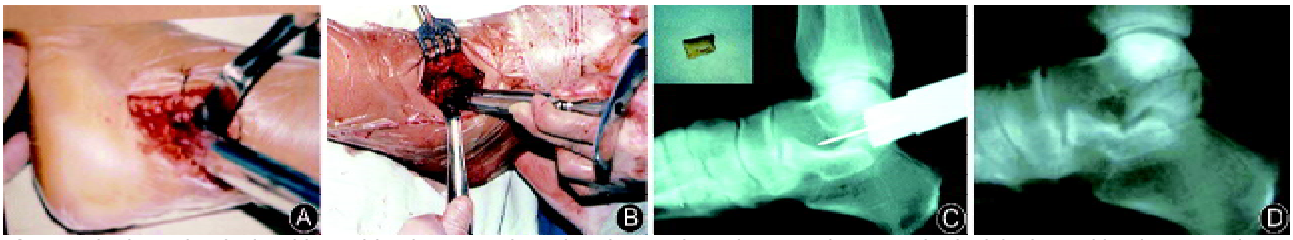

Fig.1. Subtalar arthrodesis with trephine in posterolateral and anterolateral approaches. **A:** The incision's position in posterolateral approach; **B:** The incision's position in anterolateral approach; **C:** Parts of astragalus and calcaneus are exscinded using a trephine along the direction of a guidewire and the cylinder bone bolt is taken out; **D:** The bone bolt is rotated for 90° for orthotopic transplantation.

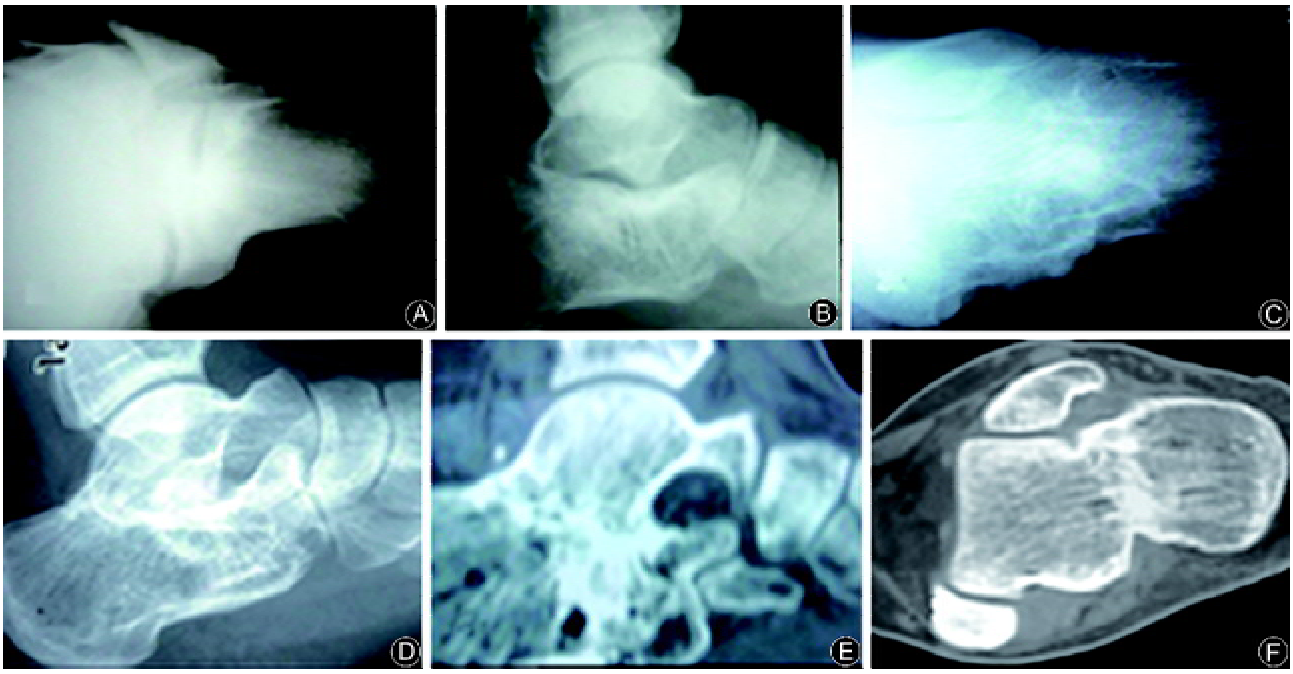

Fig.2. Radiologic observations of calcaneas before operation and 6 months after operation. **A** and **B:** Axile and lateral radiographs of calcaneas show the back clearance of talocalcaneal joints (before operation); **C** and **D:** Axile and lateral radiographs of calcaneas show the back clearance of talocalcaneal joints disappearing 6 months after operation; **E** and **F:** CT scans show no clearance between the telocalcaneal joints 6 months after operation.

RESULTS

All the patients were followed up for 45 months on average (range, 21 to 110 months). They had no complications from their operations. Primary healing was found in all the incisions 2 weeks after operation except 2 patients had skin necrosis. Porosis appeared 4 weeks after operation. Only one patient had dropfoot and unsteady walk because of plaster pressing the nervus peroneus communis. After the plaster was removed, symptoms disappeared one month later. The average AOFAS scores were improved from an average of 48.3 (range, 23 to 74) preoperatively to 79.2 (range, 45 to 94) postoperatively. This change was statistically significant ($P<0.05$) using a paired t test with 95% confidence interval. VAS pain scores decreased from an average of 7.2 (range, 3 to 10) preoperatively to 2.6 (range, 1 to 6) postoperatively. This change was also

statistically significant (P<0.05). Subjectively, 29 patients reported an increase in the number of blocks they could comfortably walk,while no patient reported a decrease in walking distance. Thirty patients believed that the appearance of their feet was improved by this operation, while one patient thought that her foot looked worse after surgery. Thirty-one patients noted an increased ability for shoewear options, two patients noticed no difference, and one felt that her shoewear options decreased postoperatively. Overall, 30 patients were very satisfied with the procedure, 3 patients were satisfied with minor reservations, and 1 was satisfied with major reservations. No patient was dissatisfied. All patients would undergo this surgery again under similar circumstances and with similar symptoms.

In radiological evaluation, 35 feet were completely fused 6 months after operation, with the successful fusion rate of 92.1%. Axile and lateral radiographs of the calcaneus could clearly show the back clearance of the talocalcaneal joints before surgery (Figs.2A and 2B). Six months after operation, axile radiograph of the calcaneus and lateral radiograph of the ankle showed that the clearance of the talocalcaneal joints disappeared (Figs. 2C and 2D). CT scans showed fusion of the talocalcancal joints and no clearance between the talocalcaneal joints (Figs.2E and 2F). Arthritis scores increased one grade in four ankles and two grades in one ankle. Midfoot arthritis scores increased one grade in four ankles. Five calcaneocuboid joints and four talonavicular joints demonstrated a one-grade increase in their scores respectively. Nonunion was found in three joints 6 months after operation and it occurred in the patients with anterolateral approach. They were effectively treated with revision subtalar arthrodesis with iliac crest bone graft.

DISCUSSION

Talocalcaneal joints are the biomechanical center of rearfeet and important structure for maintaining the stability of feet. Calcaneus and talus fractures, dislocation, injury of peripheral ligaments and degradation can all affect the normal function of feet. Arthrodeses of the talocalcaneal joints have been performed for decades in case of advanced arthroses and displacement, especially in connection with pain that cannot be managed conservatively. Posttraumatic arthroses after calcaneus and talus fractures, inborn and acquired displacements, chronic polyarthritis, and primary arthroses may be the causes of pain syndrome of rearfeet. And pain is the most important indication for operative fusions of the talocalcaneal joints.

Isolated subtalar arthrodesis needs no more complicated technique compared with triple arthrodesis, but can preserve some functions of the hindfeet.[7] The standard procedure for subtalar arthrodesis should make a lateral access to expose the talocalcaneal joints for subsequent resection of the cartilage surface. This procedure has the disadvantages of big incision, difficult exposure and no full resection of the cartilage surface. In order to achieve satisfactory union of the joints, resection of the cartilage surfaces and insertion of spongy corticocancellous chips are unavoidable. Too large or small angle of the iliac chips will affect the stability of rearfeet. Many methods of stabilizing the arthodesis have been used including staples[8] and variable screws introducing either through the talus or the calcaneus[9-12]. Therefore, secondary trauma induced by taking out the stabilizing objects is unavoidable and may enhance the occurrence of complications.

We use trephine technique to fuse the subtalar joints. The resected core bone of the trephine can perform orthotopic transplantation in the talocalcaneal joints. This method has the advantages of small incision, minimal surgical trauma, easy exposure and operation, and no injuries in the neighbouring important peripheral structures. More importantly, it can maintain the stability of talocalcaneonavicular joints and has little influence on the height of the subtalar joints and their anatomic structures. On the other hand, it does not change the biomechanics of rearfeet but can completely release pains of rearfeet. This study suggests that trephine arthrodesis of the talocalcaneal joints can aquire satisfactory clinical effects. The main operation indication of this technique is pain in a single joint. However, this technique is not suitable for patients with severe pain or complex deformities of hindfoot.

An operative technique shoud have less impact on the peripheral soft tissues and at the same time can achieve good arthrodesis results. To evaluate a successful operation we should often consider the union rate. Nonunion is always a concern with hindfoot fusion procedures. In this study, we acquired the successful fusion rate of 92.1%. Nonunion was found in only three joints 6 months after operation and occurred in the pa-

tients with anterolateral approach and without crest bone graft. Skin necrosis occurred in 2 patients with anterolateral approach. The reason may be the special anatomical structure. The resected bone bolt was generally not intact and contained fat tissues in patients with anterolateral approach, and this position had no abundant blood supply and so resulted in skin necrosis. Therefore, except for severe tarsi sinusitis, we also chose posterolateral approach for most of the patients with pain in the posterior articular surface. Crest bone graft is necessary in some circumstances. Postoperative radiographic follow-up showed different retrograde degenerations of adjacent joint arthritis, but no patients complained of pain at the talonavicular joints or calcaneocuboid joints. And none had required a conversion to triple or double arthrodesis. Arthritic symptoms may occur 15 years or longer after arthrodesis,[5] so the patients need further follow-up observations.

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